# infrared illumination

Extreme CCTV's range of active IR illumination solutions is designed to allow cameras to operate at their optimum performance levels, day and night.

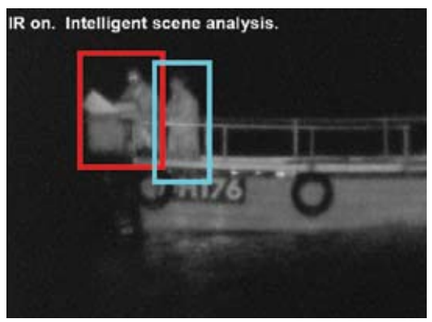
THE main benefit of active infrared illumination is its ability to produce high resolution images at night. At the most basic level, cameras need light to make pictures. The quantity of light reflecting from a scene determines the quality of the images produced – low light always results in poor or unusable surveillance images.

A common misconception regarding infrared illumination is that it provides no benefits to surveillance imaging in well-lit areas. Although there is some truth in this statement, the answer is more complex and depends on the application. As we're going to discuss later in this article there are many applications where infrared is more important during the day than it is at night.

In general night time imaging, active infrared can provide the important benefit of eliminating shadows to create an evenly exposed image. Visible lighting typically creates both bright areas and areas of shadow which degrade night viewing quality. Active infrared illumination is an important tool for critical security applications, helping to ensure proper image exposure by eliminating shadows.

By definition, active infrared illumination is between the wavelengths of 700 and 1100nm. These wavelengths are outside the spectrum visible to humans but most modern CCTV camera have some degree of sensitivity to active infrared. This means the technology is able to offer excellent monitoring performance in a covert way because people are unable to see it.

The invisible properties of active infrared illumination are an important asset for security end users who do not wish to disrupt the ambient lighting schemes of iconic buildings. One of the challenges of ambient lighting of landmark buildings – in fact of all ambient lighting on all sites – is the fact it challenges surveillance systems by filling a scene with shadows that cause darkness and areas of overexposure.




The beauty of active IR illumination is that it evens these problem areas out – maximizing camera performance without disturbing ambient lighting. Better still, active infrared lighting does not contribute to light pollution so will not disturb neighbours or generate the ire of local authorities.

Active infrared also has green credentials. Unlike traditional floodlighting, that creates hot spots and unbalanced images, Active IR illuminators are highly efficient and low voltage, producing targeted strategic lighting performance.

## SUPPORT FOR VIDEO ANALYTICS`

It goes without saying that live monitoring is an inefficient and expensive method of monitoring video streams that challenges and distracts operators. The answer is video motion detection and broader video analytics capabilities. Of course, getting video analytics right demands the best possible performance from data gathering cameras.

Video analytics works best with high quality video streams that can be defined as evenly illuminated, high signal, low noise images. One video analytics maker states that proper functioning requires images to have a signal to noise ratio of 50dB. While SNR is partly a function of good camera design, optimum performance and a high SNR can only be achieved in the presence of good lighting.

Taking this into account, active infrared can be seen as an enabling technology for the night

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time function of video analytics. Active infrared illumination eliminates the poorly-lit, noisy images typically seen under low light conditions – images make the use of video analytics virtually impossible.

It's not just video analytics that fails when night falls. Other functions commonly found on DVRs, NVRs and digital video management systems also can't operate in darkness – functions which include video motion detection, automatic alarms, false alarm suppression, video motion searching, intrusion detection event recording – all these require high SNR images to function effectively.

Bandwidth and storage are also major issues in modern networked systems. The challenge is to balance performance in terms of frame rate and resolution, with the available bandwidth and storage capacity. In most applications, frame rate and resolution are set to suit the characteristics of the network. Depending on the bandwidth of the network for example, frame rates and resolution will be reduced – and this may also be the answer for systems with limited storage capacity.

There are disadvantages to this approach, of course. Sacrificing frame rate and resolution can result in low quality video streams that may miss critical moments in a recorded event. The relevance of all this in a discussion about lighting is the fact that the use of infrared illumination reduces noisy night time images.

A poor night image with bloom, flare and areas of complete darkness will generally be as much as 20 per cent larger than a high fidelity image – this has implications for bandwidth budgets and storage. This is because noisy images show increased gain which video software interprets as motion. Along with this, the increased gain can cause false alarms if video motion detection software is fooled into identifying noise as motion.

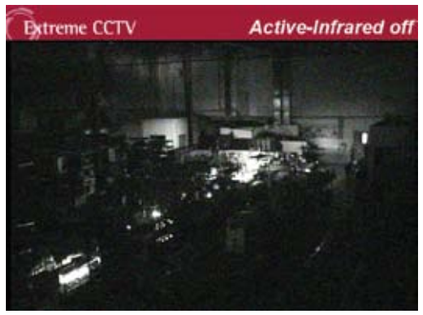
The addition of active infrared replaces noisy night time images with high fidelity night vision using invisible light the camera can see – with IR gain mode is not triggered and bandwidth requirements remain low.



These two identical dark scenes illustrate the effect of infrared illumination on the image quality and the corresponding file size. When the IR is off (left), most cameras will revert to gain mode, creating grainy images that fool a DVR/NVR into interpreting graininess as movement. The result is very poor picture quality, larger file sizes and a potential false alarm. When the IR is on (right), the camera produces a well-lit, evenly illuminated image and eliminates the need for gain mode. In this instance the file size is reduced by 25 per cent when using IR – despite containing much more information.

## THE MEGAPIXEL MOVEMENT

As megapixel cameras penetrate further into the mainstream surveillance market on the strength of their super high resolutions and wide fields of view, lighting becomes even more important. Because megapixel cameras are generally used in topical high security applications where their





An image showing how typical cameras react to uneven lighting conditions. The background underexposed and the foreground overexposed. On the right Black Diamond technology produces High Fidelity illumination and normalizes the scene producing a photonically balanced image.

extreme resolutions justify their premium costs, providing megapixel sensors with adequate light for night operation is vital.

Extreme CCTV's Black Diamond technology has created important reasons to combine megapixel cameras with infrared illumination. Black Diamond projects light horizontally and evenly in rectangular beam shapes as wide as 135-degrees with a vertical height as focused as 10 degrees. This evenly projected wide beam pattern is ideally suited to megapixel camera operation. High fidelity illumination not only produces outstanding night time images but optimizes the megapixel camera's dynamic range.

In addition, megapixel cameras are typically larger than traditional CCD sensors and produce a wider field of view at any given distance. Black diamond technology is the world's first infrared illuminator designed specifically for megapixel surveillance. By generating horizontal fields of view up to 135 degrees, Black Diamond produces the wide angle illumination beam patterns required for effective megapixel night vision.

In a megapixel world with edge devices sporting video analytics, cameras will be able to identify and respond to events. To achieve this, however, systems will need to be supported by lighting systems that not only operate effectively but also don't suffer from degradation in quality over time. Derwent Systems' Constant Light solutions are designed to offer this sort of performance integrity.

## CAMERA FUNCTION IN LOW LIGHT

How important is light, and the quality of light, to the quality of images obtained by a surveillance camera? Consider that most camera makers claim very low minimum scene illumination numbers down to 0.1 lux or even lower. And while manufacturers insist their cameras operate in extreme low light, it's generally accepted in the industry that these images are invariably useless.

Improvements in the dynamic ranges of typical CCTV cameras enable the capture of images across a wide range of lighting conditions. However, a critical point is that the camera can only respond effectively to a limited range of the spectrum at any one time. Most cameras cannot respond effectively at 2 ranges simultaneously. The most common manifestation of this principle is a point source of light (at Point A, for example) in a dark scene (B). In such a scene, the resulting image shows A as a very bright hotpsot while dark areas at B become even darker.

Images such as the one described above generally show both overexposure (bright areas too bright) and underexposure (dark areas too dark). In general, the more varying the light conditions in a scene, the more difficult it is for a CCD to adapt. Most CCDs respond by using an average exposure somewhere in between the dark and light areas. Unfortunately the technique is usually ineffective and a scene within both bright and dark areas will wreak havoc on most cameras.

Extreme CCTV's Black Diamond technology advances even illumination infrared which it pioneered and patented nearly a decade ago. Black Diamond technology products high fidelity illumination designed specifically to optimize camera performance by normalizing the lighting conditions. Overexposure and underexposure are eliminated from foreground and background with the resulting night time images photonically balanced.

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## REFUTABLE EVIDENCE

Active infrared derives its name from its role in the imaging process. A scene is actively illuminated by the infrared. The target object reflects the infrared illumination back to the camera which uses it to make an image. The active role of infrared illumination in making an image contrasts with the passive role of thermal imaging systems. Thermal imaging passively detects differences in heat differentials on scene and uses those differentials to create an image.

The other main difference between active infrared illumination and thermal imaging is the wavelength of the light used to make the images. In active infrared, the wavelength is 700-1100nm, while in thermal imaging, the wavelengths typically range from 1500-5000nm, depending on the application. In practical terms, active and passive wavelengths produce very different images. Thermal imaging is outstanding for obtaining detection and classification-level video.

Active infrared complements thermal imaging by providing recognition and identification level video. Used in combination, thermal imaging and active infrared night vision enables potential threats to be identified in the least amount of time. The combination of active infrared and vision and thermal imaging is ideally suited for applications where response time is a critical factor.

Additionally, the high resolution images produced by active infrared systems may be used as irrefutable evidence in a court of law. Properly installed systems will deliver irrefutable images that show distinguishing features of a person's face allowing positive identification.

Irrefutable evidence, especially when it provides identification-level video, can often make the difference between between successful investigation and a futile one. The highest profile example of this is probably the 2005 London Underground bombings where Extreme CCTV's cameras helped deliver evidence that authorities used to arrest alleged plotters mere days after the event. It's without question that irrefutable evidence gathered from the cameras round the incident locations was absolutely critical to the investigation.

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**IR IN THE DAY TIME.**

Infrared illumination also has value during daylight hours. The reason lies in Ambient Rejection technology that Extreme pioneered in its REG license plate capture cameras. The principle behind Ambient Rejection revolves around precisely controlling the light the camera sees. In most applications, the lighting conditions experienced by cameras is irregular and uncontrolled. As such, factors such as sunlight glare, darkness, hotspots and contrast confuse the camera and reduce its effectiveness at producing usable images.

Ambient Rejection technology works by filtering the irregularities of unwanted ambient lighting (parasitic lighting) while providing a precisely controlled infrared light source for the camera to see. The result of Ambient Rejection technology is uniform and predictable images under all ambient lighting conditions.

License plate capture is a technical minefield yet as a component of overall site security, vehicular access control is the first line of defense. As a means of providing identification, vehicles are inherently linked to identity through its license plate. Extreme CCTV's REG license plate capture cameras employ Ambient Rejection technology that employs a DHC imaging engine that uses active infrared illumination to overcome the challenges of retro-relectivity, headlights, speed and sunlight glare.

A vital element of all this is the ability to provide effective illumination through car windows. This is a formidable technical challenge because glass creates a mirror-like glare and reflection that cameras are unable to penetrate. Ambient Rejection uses optical filtering and infrared illumination to overcome the effects of glare. Extreme's DriverView camera is able to support applications like border control, tolling, car parking and other traffic management applications.

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Other application-based solutions Extreme is currently working on include identification of containers for the transport industry – the Container Camera – as well as face recognition solutions. Another new development is DCRI imagers that integrate a mechanical tilt positioner with a thermal imager for detection and active infrared for identification. The multi sensor design draws on the strengths of thermal imaging for detection and classification while using the high resolution capability of active infrared for recognition and identification. In a fully integrated version, the pan/tilt positioner is integrated with multi-sensor optics to automatically track threat vectors and obtain a positive identification.

Another very capable solution from Extreme is the ARGC-2400 – a range-gated active imaging system that provides long range night vision through airborne obscurities like rain snow and fog. It's able to read a license plate at 1500 metres, recognize a human at 5000 metres and classify vehicles at 10,000 metres.